COTTON TIRE CORD: PRESENT AND FUTURE USE IN TIRES[1/]

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It is a genuine pleasure for me to meet with you and to take part in your annual conferences.

In one important respect, your interest as tire dealers, and the interest of the organization of which I am a member, are identical in regard to the use of cotton in tires; that is, we are both constantly seeking accurate, up-to-date information on the relative value of different types of tire cord for different classes of tire service.

As tire dealers, you use this information as one means of keeping abreast of current developments in the product which you sell, and in advising your customers; we use this information as a basis for the selection and guidance of our research on cotton tire cord.

The data and other information which I am going to present has been gathered throughout the course of a number of years in an effort to obtain, for our own use, accurate information on the technical and economic considerations which determine the relative use of cotton and competing materials in tires. It has not always been an easy matter to separate fact from fiction, to properly interpret apparently simple data, and to weigh the relative importance of various technical and economic factors.

Before taking up the use of cotton in tires, I should like first to bring to your attention two simple facts about cotton as a textile raw material. These two facts hold true for almost any kind of commercially produced raw material, but they are often overlooked, or ignored, when cotton is discussed as a raw material for use in tire cord.

The first point I want to bring out is that there is not just <u>one</u>, but <u>many</u>, different qualities of cotton grown in this country, and that the serviceability of the products made from these different qualities varies accordingly and over a wide range, frequently as much as several hundred percent.

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2/ One of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

The second point is the simple but important fact, that the higher the quality of the cotton, the more it costs to produce, and the higher its cost to textile manufacturers.

The first of these two facts is of importance in appraising the value of cotton on a straight basis of what is physically possible, while the two taken together determine the commercial feasibility of using a particular quality of cotton in any particular product. Recognition of these two facts will make it evident that economic as well as technical considerations are of major importance in determining whether cotton or some other fiber is used in tire cord.

In the discussion which follows, frequent reference will be made to the use of different qualities of cotton. From a technical standpoint, the definition of quality in cotton is highly complex, so I would like to define only the principal element and use this single measure to indicate different qualities. The principal quality element in commercially grown cottons is what is known as "staple length," a measure associated with the average length of the fibers. On this basis, cottons are known as short-staple, medium-staple, and long-staple, with actual lengths, to the fraction of an inch, to indicate finer differences. In general, the longer the staple length, the higher the overall quality of the cotton, and the more durable will be the product made from it.

As a background for this discussion on the present and future use of cotton in tires, let me trace briefly the development of modern pneumatic tires from the standpoint of changes which have occurred in fabric requirements. I think you will find such information helpful in appraising the present status of cotton in tires, and helpful to a better understanding of the factors upon which its future in this use will depend.

Beginning first with the old fabric-type of tire, which most of you remember, the principal tire developments which have influenced fabric requirements were the high-pressure cord tire, followed by the development of the low-pressure cord tire, and then by changes in tire requirements brought about by the tremendous expansion in our highway systems, beginning in the late 1920's and extending into the 1930's.

In both the old fabric-type tire and in the high-pressure cord tires, high carcass strength was a prime requirement, and only the highest quality, long-staple, most expensive, domestic and imported cottons were used. When the low-pressure cord, or balloon, type of tire was developed in the early 1920's, however, there was a radical change in carcass requirements. With this type of tire, having a greater volume, and being inflated to lower pressures, the stress on the carcass was greatly reduced. High cord strength became of secondary importance to resilience in the cord, and to the ability of the cord to withstand comparatively sharp flexing.

With strength requirements on the cord reduced, there was a corresponding rapid shift to the use of shorter-staple, less expensive cottons, with the medium and shorter lengths predominating.

The last of these three developments - the tremendous expansion in our highway systems - brought about a sharp increase in the number and size of high-speed inter-city trucks and busses. This meant an increase in the demand for tires that would carry greater and greater loads. Greater loads, in turn, brought about the requirement of greater carcass (and cord) strength, and greater cord strength required the use of long-staple, high-quality cottons.

So, by the middle 1930's, the tire industry was using two fairly distinct types of cotton cords: high-strength cords, made from the longer-staple cottons, for use in medium and heavy-duty truck and bus tires, and lower-strength cords, made from the shorter-staple cottons, for use principally in passenger car tires.

In all of these developments leading up to the present modern pneumatic tire, cotton had no real competitor. Silk, flax, hemp, ramie - almost every other available kind of fiber - had all been tried, at least experimentally, and had been found inferior to cotton. As a consequence, in all of these past developments, the price of cotton of different qualities was of no consideration except in regard to within-the-industry competition, which was, and still is, extremely keen.

This was the picture in regard to cotton when rayon tire cord was introduced commercially in 1937. With the commercial introduction of a satisfactory rayon cord, the price of cotton has become of increasing importance.

There has probably been more written and said during the past few years about the relative merits of cotton and rayon for tire cord than about any other development in the history of tires. Moreover, much of the information released on this subject has been difficult to interpret and to appraise accurately. In the discussion which follows, I will avoid, so far as possible, all controversial phases of this subject.

Most of the advantages claimed for rayon arise from the fact that present types of rayon cord are stronger than present types of commercial cotton cord, on both a diameter and a weight basis. But that is not the whole story. In comparing the relative value of two types of cord for making tires, the true comparison should be made on the basis of which fiber can be used to produce a tire which will give a higher useful mileage per dollar, regardless of the relative quantity of the two materials used. "Useful mileage" is understood to take into account trouble-free mileage as well as total mileage. If the useful service life is equal, then relative cost of the tires becomes the determining factor.

In making an appraisal of the relative value of cotton and other fibers for use in tires, two facts must be borne in mind: (1) that better cotton cords than those which are being commercially produced today can be produced by using higher-quality cottons; and (2) the relative importance of the physical properties of different types of tire cord depends upon the class of tire service into which they go.

The use of higher-quality cottons is at present restricted because of their higher relative cost, and failure to use them should in no way be construed as a criticism of tire and tire cord manufacturers. I will have more to say about this later.

Let us consider now in more detail the relative importance of differences in the physical properties of cord for different classes of tire service.

As tire dealers, you know that the primary requirement on a tire is that it have and maintain adequate carcass strength under the conditions which it encounters in service, and that it be of such a size and construction that the running temperatures will not be so high as to cause uneconomical treadwear or failure of the rubber and fabric components. You know also that the thicker the carcass of a given size tire, and the higher its operating speed, and the more it is overloaded, the hotter it will run.

In very large tires run overloaded at sustained high speeds, the development of high temperatures is a serious problem. In this type of service, the higher strength-weight and strength-diameter ratio of rayon, as compared to present commercial cotton cords, is a decided advantage. By the use of rayon, these very large tires can be made with an appreciably thinner carcass of considerably greater strength under operating conditions. The difference in performance is so great, by comparison, that tires made with present types of cotton cord are considered unsatisfactory and there is no question of relative cost involved.

Moving to another class of tire service where heat is definitely not a problem, we have tractor and implement tires. In these tires, adequate carcass strength is the principal, and almost sole, consideration. It is, therefore, a simple question of putting enough cotton or other type of fabric into the tire to give adequate carcass strength, with relative cost and availability determining which type of fabric will be used.

Let us consider passenger car tires next. Passenger car tires, of course, constitute the largest part of the tire market and also the largest market for textiles in tires, taking in prewar years about 65-70 percent of all tire fabrics produced. Except for a small proportion of the total number of tires used in this class of service, the development of heat is not an important problem, adequate carcass strength being the prime requirement. In most of these tires, present types of commercial cotton cords are adequate, but better cotton cords

can be produced by using higher quality cottons, and it is physically possible to make an entirely satisfactory passenger car tire from cotton; that is, satisfactory from the standpoint that the carcass will outlast the tread.

Moving further up the tire scale, we have small- and medium-size tires for pickup trucks, produce trucks, inter-city hauling, etc. In some of these classes of service the development of heat is a serious problem, and in others it definitely is not. Small- and medium-size truck and bus tires represent borderline cases where the relative cost of cotton and other types of fabrics is of varying importance with respect to their physical properties. Again we have the fact that better cotton cords can be produced by using higher quality cottons, but at an increased cost.

Perhaps you would be interested in the quantitative results of some road tests which illustrate this point. Back in late 1943 when the rubber companies were carrying on intensive research to develop synthetic rubber tires for the Army, the Southern Regional Research Laboratory had some military tires built for testing at the Army's proving ground at Camp Normoyle, Texas. This is where military tires were subjected to tests simulating combat conditions, and usually referred to as bruise-break or shock tests. The tires were of the 7.50-20, S4, mud-and-snow tread type, the military truck tire used in largest quantities during the war, principally on the Army's 2-1/2 ton, 6 x 6 cargo truck. This truck was the workhorse of the Army, and, incidentally, until the very end of the war, all of these tires were made with cotton cord. One group of test tires contained regular-production, commercial cotton cord, and three groups contained cord made from longer-staple, selected varieties of cotton which, on the basis of laboratory tests, seemed to possess properties especially suited for making improved cords. With the commercial cotton cord tires rated at 100, the average mileages obtained with the other three groups of tires containing improved cords were 138, 200, and 250. In this type of test, heat was not a major factor and the superior performance of the tires made from the longer-staple varieties of cotton was due primarily to their higher cord strength.

In the late summer of 1944, tests were run by the Government Tire Test Fleet at San Antonio, on 7.00-20, S4 highway-tread tires, made with regular commercial cotton cord and with cord manufactured from the variety of cotton that had showed up best in the Army tests. In rear wheel positions, with a 30 percent overload, heat was definitely a factor, and the tires made from the long-staple variety of cotton gave an average mileage to failure of slightly more than three times that obtained with the regular commercial cord made from a shorter-staple cotton.

Similar tests are now in progress on 9.00-20 highway-tread tires run on trucks representing four different service conditions, from underload

to overload, and from moderate-speed to high-speed operation. No failures, other than a few tires which were cut through with glass or punctured by bolts, have occurred to date, so I cannot give you any up-to-date data on the relative performance of medium- and long-staple cottons in this size tire. However, the tires of one group, carrying up to a 40 percent overload, are now running at 42,000 miles on their first recaps.

A moment ago I mentioned the higher cost of these long-staple cottons. At present price levels, even the fabrics made from medium- and short-staple cottons are not competitive on a cost basis with rayon. Although the performance of cords made from long-staple cottons is markedly superior to those made from the medium- and short-staple cottons, the added cost is so great at present price levels that such cords are not competitive on a cost-quality basis with either rayon or present types of commercial cotton cords.

I have also mentioned the fact that in the middle 1930's, both long- and medium-staple cottons were being used in large quantities in tire cord. This is not true today, and although their almost complete disappearance may be accounted for by the fact that the truck and bus tires in which they were formerly used are now being made from rayon, this explanation is too abbreviated to give a true picture of what actually happened.

In 1937, when rayon made its appearance in tire cord, tire fabrics made from even the highest quality domestic and imported cottons cost less than these early rayon fabrics. Rayon was recommended then only for very large tires run overloaded at sustained high speeds. From that point on, however, the price of rayon tire fabrics steadily declined and their quality improved, while the price of cotton fabrics of all qualities steadily increased. For example, in 1937, the basic price of raw cotton was 9 cents per pound, with the price of tire-cord qualities somewhat higher. In 1941, the basic price of cotton had risen to 18 cents, and today, October 16, it is 38 cents.

In regard to the price of cotton, I wish to make it very clear that my remarks in this connection are not to be interpreted in any way as implying what the price of cotton should be. I am simply pointing out the influence of price on the use of cotton in tire cord.

Thus, during the very time that cotton fabrics were facing increased competition from rayon, the price of raw cotton underwent a four-fold increase. This sharp rise in cotton prices not only prevented tire cord manufacturers from going to higher-quality, longer-staple cottons in an effort to meet the increasing competition from rayon, but actually caused a shift to lower-priced, shorter-staple cottons. There were also other, less influential factors, which I shall not mention, which were operating during the war in such a manner as to cause this shift to shorter-staple, lower-quality cottons.

Today, as I mentioned a moment ago, tire fabrics made from even the shorter staple lengths of cotton cost more than rayon fabrics. Paradoxically, more cotton tire fabric is being produced today than in prewar years. The explanation of this paradox is simple, however, and I believe it is fairly generally known. Specifically, the average annual prewar market for tire fabrics was about 225 million pounds. In 1945, the rubber industry use of tire fabrics was 530 million pounds, with demand running at about the same rate this year. Production capacity for rayon cord is only a little more than 200 million pounds annually. In other words, even though rayon fabrics are cheaper today than cotton fabrics, tire manufacturers are using almost every pound of both types they can get their hands on in order to supply the current, abnormally heavy demand for replacement tires.

As you know, practically all of the rayon produced today is going into truck and bus tires. As soon as the supply of rayon catches up with the current, heavy demand for these tires, more rayon will be available for possible use in passenger car tires; and it is then that relative cost of cotton and rayon fabrics will become an important factor in determining their relative use. What their relative prices will be at that time, no one can safely predict, and I, for one, am certainly not going to attempt it.

This brings us to the question: "What is the future of cotton in tires?" The answer to this question is dependent upon a multitude of factors whose course it is not possible to predict. Hence, it would be foolish even to attempt a definite answer. It is possible, however, to point out the principal factors upon which the future of cotton in tires will depend.

First and foremost is the factor of relative prices of cotton fabrics and fabrics made from other fibers, the chief one at present being rayon. If the relative prices of cotton and rayon should stay at prevailing levels, and if the relative qualities of cotton and rayon fabrics should remain unchanged, the use of cotton will undoubtedly gradually decrease until only a minor portion of all the tires produced will be made with cotton cord. Unless we should experience a rather serious depression, however, which would reduce the total demand for tire fabrics, this displacement will take several years. That is, anticipated production capacity for rayon cord during the next year or two is not great enough to supply the anticipated total demand for tire fabrics. This statement should be qualified by mentioning the possibility of a satisfactory cord being developed from rayon staple fiber at a price competitive with cotton cord. Rayon staple fiber is, as you know, rayon produced in the form of discontinuous lengths and spun into yarn the same as is cotton, in contrast to the continuous filament type now used in tire cord. Considerable research is being devoted to this end, and success along this line would bring into use a large additional existing production capacity.

On the other hand, if relative prices should change sufficiently to make possible the use of higher-quality, longer-staple cottons on a competitive cost basis with rayon, there would be a performance basis for cotton to maintain the major part of its tire market, at least in passenger car tires. That is an over-simplified statement, however, for there are many other factors involved, such as price stability of cotton, manufacturers' anticipation of future trends in cotton prices, and the policies and future plans of tire manufacturers.

Next to price, the most important factor affecting the future of cotton involves changes which it seems almost certain will be made, through research, in the quality of cotton cord and cord made from competing fibers. This statement should perhaps be broadened to include the influence of developmental work on new or modified fabric constructions, for considerable research is being carried on along this line by practically all tire manufacturers.

In regard to improvements in the quality of cotton tire cord, there are at least two, and no doubt more, new types available now which have already been proved on the road to give superior performance. They are not being produced commercially today because the processing costs are higher and the current price situation is unfavorable relative to the types of cord with which they would compete. And there is no reason to believe that the end is in sight for further improvements in the quality of cotton tire cord. Our laboratory in New Orleans is carrying on extensive research on this problem, and considerable research on cotton tire cord is also in progress in the laboratories of tire and tire cord manufacturers, though not on as large scale as before rayon, wire, nylon, and other types of cord entered the picture. In particular, there is an increasing amount of fundamental research aimed at determining the exact nature of the mechanical and heat failures of cords in service, and an increasing amount of research directed toward the development of chemical and other treatments to prevent such failures.

On the other hand, one can also safely anticipate future improvements in the quality of cords made from materials other than cotton. Some improvements are ready now for commercial application. I will not mention any of these because there are other speakers on this program who will undoubtedly cover those developments.

To get back to the main question "What is the future of cotton in tires," I must frankly confess that I know of no definite answer. Only one thing is certain: Tire cord and tire fabrics represent the largest single domestic market for textiles, and competition for this prize is, and will continue to be, of the keenest type. It is going to be rough, with no holds barred, just as it has been in the past. In the long run, this market will be divided on the basis of which fiber offers the greatest useful-mileage-per-dollar value for different classes of tire service. Whether tires of the future will be made from cotton, rayon, nylon, wire, or some new synthetic fiber, however, we can be assured that the tires which you sell and which you and I run on our own cars will be of increasingly higher quality.